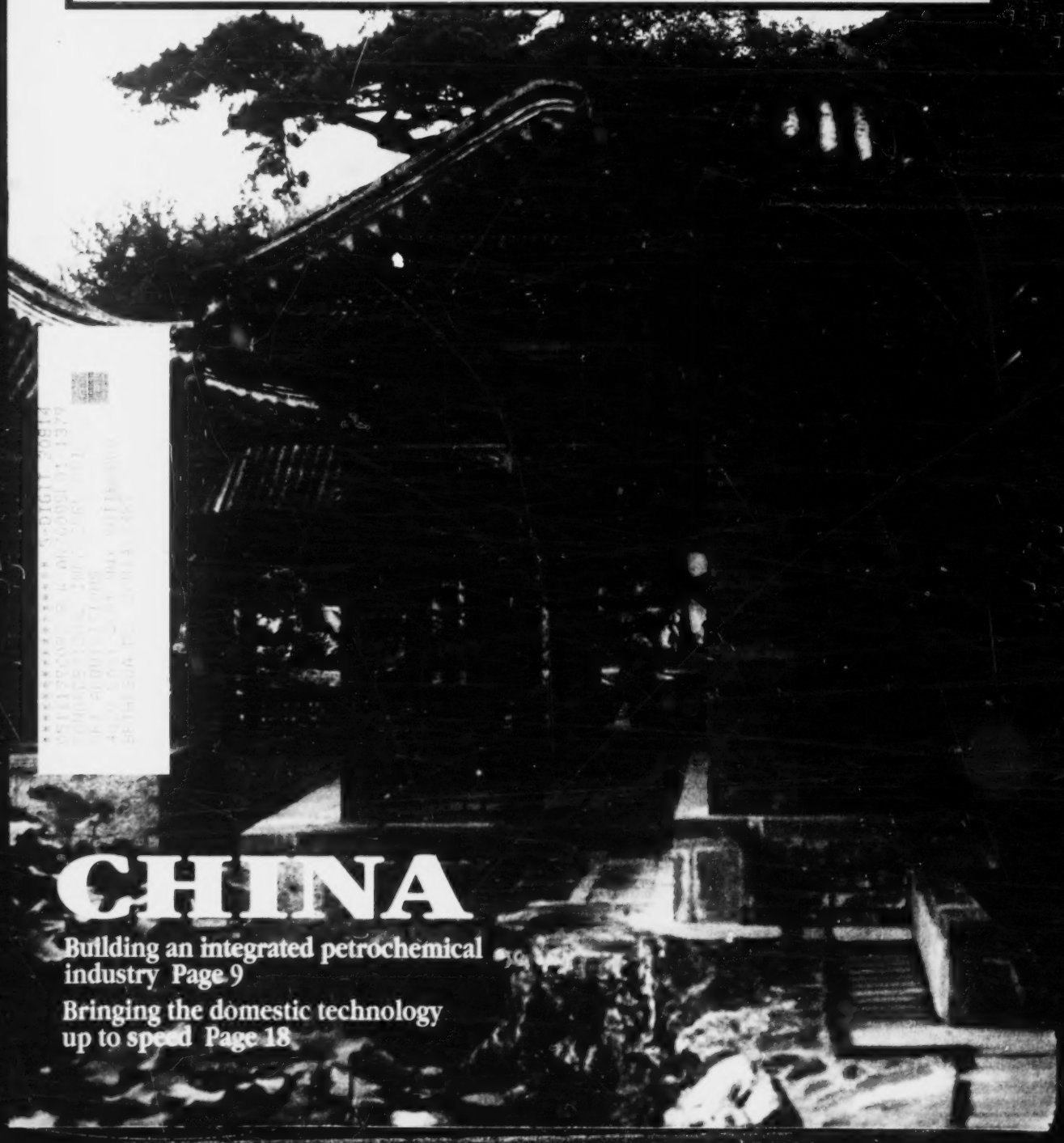
CHEMICAL & ENGINEERING NEWS

C&EN

FEBRUARY 24, 1992

SYNTHETIC SELF-REPLICATING MOLECULES SHOW SOME SIGNS OF LIFE PAGE 21



# CHINA

Building an integrated petrochemical industry Page 9

Bringing the domestic technology up to speed Page 18

CHEMICAL & ENGINEERING NEWS

C&EN

FEBRUARY 24, 1992

## NEWS OF THE WEEK

■ OSHA issues its new process safety management standard, expected to significantly reduce catastrophic fires and explosions at chemical facilities. **Page 4**

■ A number of chemists and chemical engineers are among the 79 new members and seven foreign associates elected to the National Academy of Engineering. **Page 4**

■ Legislators blast forced resignation of NASA's chief, Adm. Richard Truly, as well as proposed agency budget. **Page 5**

■ EPA reverses proposed ban on many uses of family of fungicides, ethylenebis(dithiocarbamates), finding they pose cancer risks much lower than previously thought. **Page 6**

■ Comprehensive energy bill passes Senate by vote of 94 to 4; final bill lacks two most contentious provisions, which would have opened the Alaska National Wildlife Refuge to oil drilling and mandated fuel economy standards for autos and trucks. **Page 6**

**COVER: Pavilion at Imperial Summer Palace near Beijing. Photo by C&EN's Joseph Haggin**

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**National Institute of Standards & Technology,** headed by chemist John Lyons, intensifies its role of serving as government's link with industry. **Page 13**

**EPA and various states' agencies** use some innovative investigation techniques as they sleuth for companies not complying with nation's hazardous-waste laws. **Page 15**

**International alliance of legislators and environmental** activists pressure Administration to change its carbon dioxide emissions policy. **Page 16**

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**General catalytic method gives single enantiomers** of α-amino acids from cheap achiral starting material. **Page 23**

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## ACS NEWS

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**Recruitment of more minorities into the chemical sciences** is the goal of an implementation task force set up recently by the society. **Page 40**

## BUSINESS

**China's Sinopec is poised to play a big role in the global petrochemical market following modernization of its facilities at home and expansion of its operations overseas. Page 9**

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# LETTERS

## Modernizing p-chem labs

Upon reading the report (C&EN, Jan. 6, page 29) that describes the physical chemistry project (mid-Atlantic consortium) I was once more depressed by the apparent equating of the use of state-of-the-art "black boxes" with methods for teaching the fundamentals of physical chemistry laboratory operations. Upgrading laboratory programs seems to be identified with the exposure of students to highly integrated, computer-based, complex devices that were primarily developed by apparatus manufacturing companies for analytical services.

Apparently I am old-fashioned. I am of the opinion that p-chem labs should provide students with hands-on experience on methods for characterizing materials: measuring their physical properties, such as heats of formation, molecular structure, absorption and emission spectra, dipole moments, surface tension, viscosity, thermal conductivity, diffusion, and so on; the nature of transformations, such as phase changes, coexistence conditions, adsorption, electrode reactions, and the like; and rates of interconversions that incorporate kinetics, photochemistry, and nuclear processes.

Of course, there isn't enough time to cover all of the above. Hence, in my lexicon, upgrading should result in a return to more lab hours devoted by students to experiments that embody basic principles of physical measurements, not by bringing into the laboratory devices that require a minimum amount of training to push buttons on a computer-controlled, highly integrated device that prints out predetermined answers.

Current activity in physical chemistry research is way beyond what can be illustrated in the first laboratory course. Demonstration of current activity is best reserved for carefully illustrated lectures that build on the fundamental principles uncovered during the direct involvement of students with well-designed experiments. Such lectures can best show how these principles were utilized and integrated into the black boxes that command high prices.

Consider two examples. To tell students that they are recording an absorption spectrum with a Fourier transform infrared instrument is false; that device records the Fourier transform of the light that enters the interferometer through a wide aperture. An honest teacher must then decide whether he or she wishes to emphasize principles of optics or the infrared properties of materials. When the teacher decides on the latter, the FTIR becomes a black box. Then an honest teacher must decide whether to tell students that the ratio of intensities of the split rotational lines in the HCl fundamental band gives the wrong 35/37 isotope ratio, and to note the effect of pressuring the HCl with added argon.

The C&EN report reads as though lasers are the hottest item in the arsenal of physical chemistry operations. About 25 years ago there was much preoccupation with chemical lasers, and some very interesting chemistry evolved as a consequence. Regrettably, the indicated use of lasers in 1992 appears to be restricted to treating them merely as super light sources.

I ask why—and cannot escape the conclusion that part of the pressure to bring new toys into the laboratory is an attempt to beguile students and give them a bit of "gee whiz" for the trouble they experience by participating in the course.

**Simon H. Bauer**
*Professor of Physical Chemistry*
*Baker Laboratory of Chemistry*
*Cornell University*

## Heat release phenomenon

One book that was reviewed on cold fusion (C&EN, Jan. 13, page 28) seemed to suggest that the excess heat release phenomenon observed in some experiments may be real, and partly for that reason some workers remain hopeful of a positive outcome. As a sideline observer of this spectacle, I have waited and listened—long and patiently, but in vain—to hear the admission that electrolyzing

### Correction

• Jan. 20, page 5: At room temperature and atmospheric pressure, graphite is a more stable phase of carbon than diamond. However, at pressures of 2 gigapascals and above, diamond is the more stable phase.

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# China's Sinopec Sets Sights on International Petrochemical Market

■ ***Consolidation at home and expansion abroad have given Sinopec a sound base for its move into the global arena***

**Joseph Haggin,** C&EN Chicago

The dominant organization in the Chinese petrochemical industry is China Petro-Chemical Corp. (Sinopec). Since 1983, Sinopec has managed to organize China's oil and gas companies into an unusually profitable unit. Sinopec is now expanding its operations overseas, modernizing its facilities at home, and preparing to play a major role in international petrochemical markets. How successful Sinopec's plans turn out to be probably will depend to a large extent on future economic and industrial reforms that are in the works.

Not surprisingly, one of the biggest Sinopec enthusiasts is its president, Sheng Huaren, who has been presiding over the vast conglomerate since 1990, when he replaced former president Chen Jinhua. Chen was moved up to become director of the State Commission for Restructuring the Economic System. The success of Sinopec may have been something of a model for industrial planners in China, who continue their efforts at restructuring.

Last September, Sheng told a plenary session of the International Conference & Exhibition on Petroleum Refining & Petrochemical Processing (Interpec China 91) held in Beijing that Sinopec had every intention of becoming an international player in the petrochemical business. To him that meant consolidating production at home and expanding abroad wherever the profits would lead. Like most Chinese industrial leaders, Sheng is keenly aware of the importance to China of foreign credits. Sinopec is also a main avenue for the introduction of high-tech science and engineering into China and a key channel for technical expertise that China is now avidly seeking (see page 18).

When the communists took over the mainland in 1949, China had only several small oil refineries, and more than 90% of the crude oil processed was imported. Sheng says development of the Daqing oil field provided self-sufficiency in oil for China by 1963. This prompted further exploration and development, which was stalled by the internal problems associated with the so-called Great Leap Forward and the Cultural Revolution conducted by Mao Ze-dong.

Following Mao's death, reform was speeded up and numerous chemical manufacturing complexes were started and operated independently with little coordination. The chemical industry was almost exclusively focused on domestic production.

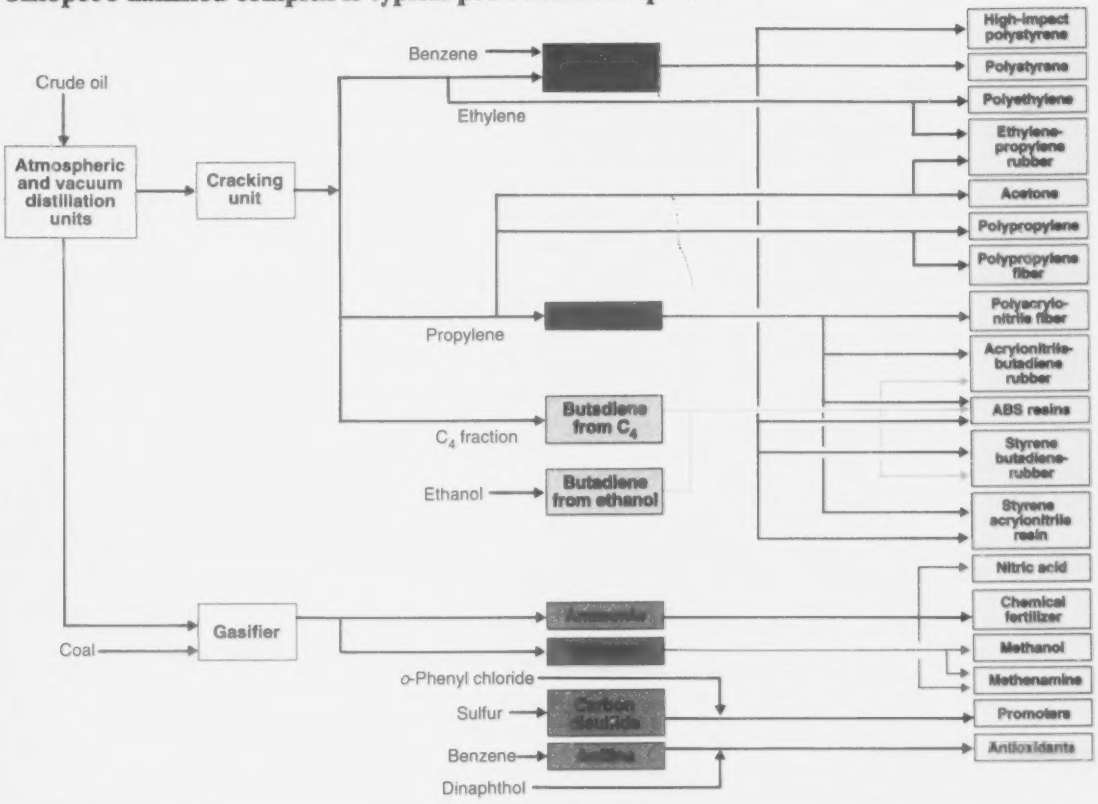
Sinopec was founded in July 1983 with domestic capital of about $3.9 billion at current exchange rates. It is a state-operated corporation reporting directly to the State Council of the government. The principal business of Sinopec is oil refining and petrochemical production from crude oil and gas. The corporation also manages Sino-foreign investment enterprises in petroleum and petrochemicals at home and abroad.

As of the beginning of this year, Sinopec controls more than 70 subsidiaries, which operate 38 refineries, 21 basic organic chemical facilities, 15 synthetic fiber facilities, five synthetic rubber plants, three synthetic resin plants, 13 chemical fertilizer facilities, five construction companies, seven research and design institutes, and six trade and sales organizations. Total work force is about 830,000 people, including 75,000 scientists and engineers and about 200,000 people in the sales force. The corporation has branch offices in Japan, the U.S., Germany, Thailand, Ecuador, and Hong Kong.

## Sinopec has long list of major subsidiaries

- Yanshan Petrochemical Corp.
- Tianjin Petrochemical Co.
- Fushun Petrochemical Co.
- Jinzhou Petrochemical Co.
- Dalian Petrochemical Co.
- Liaoyang Petrochemical Fiber Co.
- Gaoqiao Petrochemical Co.
- Jinling Petrochemical Co.
- Yangzi Petrochemical Co.
- Qilu Petrochemical Co.
- Baling Petrochemical Co.
- Maoming Petroleum Industry Co.
- Lanzhou Chemical Industry Co.
- Daqing General Petrochemical Works
- Shanghai General Petrochemical Works
- Lanzhou Petroleum Processing & Petrochemical Complex
- Jinxi Petroleum Processing & Chemical Complex
- Zhenhai General Petrochemical Works
- Anqing General Petrochemical Works
- Guangzhou General Petrochemical Works
- Urumqi General Petrochemical Works
- Shijiazhuang Refinery
- Cangzhou Refinery
- Qianguo Refinery
- Harbin Refinery
- Lunyuan Refinery
- Fujian Refinery
- Jiujiang Refinery
- Jinan Refinery
- Luoyang Refinery
- Wuhan Petrochemical Works
- Jingmen Refinery
- Hubei Chemical Fertilizer Plant
- Sichuan Vinylon Plant
- Ningxia Chemical Works
- Dushanzi Refinery
- Yiping Chemical Works
- Changcheng Premium-Grade Lube Oil Co.

**Sinopec's Lanzhou complex is typical petrochemical operation**




By its own estimate, Sinopec processes about 90% of China's crude oil, gas, and petrochemical products. At the end of 1990, the fixed assets of Sinopec were valued at $17 billion. Sales revenue was about $12 billion, with taxable profits estimated to be $3 billion.

As an indicator of the growth of Sinopec since the reforms began in 1983, Sheng notes that, between 1983 and 1990, Sinopec put on stream four 300,000 metric-ton-per-year ethylene plants at Daqing (Heilongjiang province), Qilu (Shandong province), Yangtze (Jiangsu province), and Jinshan (Shanghai). Several others are now in various stages of construction. In addition, three 300,000 metric-ton-per-year ammonia plants and three 520,000 metric-ton-per-year urea plants were built at Zhenhai (Zhejiang), Urumqi (Xinjiang), and Ningxia.

Most of the developments in the petrochemical, and most other industries, correspond to a series of five-year plans promulgated by government planners. The eighth five-year plan began in 1990. For Sinopec, the government has stipulated that total ethylene production be increased to 2.3 million metric tons per year in 1995 and then to 3 million by 2000. This means at least 18 new major projects will be financed within the corporation or via joint ventures. Included are eight ethylene projects, three chemical fiber projects, three large fertilizer projects, and three deep-catalytic-cracking projects for the refineries.

All this production entails a large sales and promotional effort, and a corresponding marketing organization has been developed to suit China's planned economy at home and potential free market customers abroad. This means marketing about 1500 different products, often to customers who are not familiar with them. Private conversations with several Sinopec marketing people strongly suggest that much of Sinopec's marketing effort would be considered technical service elsewhere.

Sinopec's growing foreign trade is not yet a challenge to most international producers. However, it is significant. In 1990 Sinopec exported about 6 million metric tons of various oil and petrochemical products with a value of $1.4 billion. The total import volume was valued at about $354 million, of which $110 million was spent on imported technology and equipment. Imported chemical raw materials cost China $152 million in 1990, and $49 million was spent on metals and nonmetals. In 1990, Sinopec signed loan agreements totaling about $80 million. These will help finance 11 joint-venture projects, including the Fushun acrylonitrile plant.

Sheng also reported on the investment in R&D. Present plans call for heavy investment in 10 major areas:

- New technology for the deep processing of heavy oil for increased yields of middle distillates.
- Higher quality feedstocks for olefins and aromatics.
- New technology for olefins and aromatics production.

• Improved technology for making fine chemicals with high added value.
• New technology for catalysts and additives.
• New processing for and applications of plastics.
• A new attack on corrosion prevention, plant safety, and environmental protection.
• Improved instrumentation, simulation, and control.
• Development of new petrochemical materials.
• Development of a new high-tech R&D effort to extend into the next century.

The efforts of Sinopec have already shown some effects abroad. On Jan. 5, Liu Mingyu, chairman of the board and president of China National Chemical Construction Co. (CNCCC), China's major overseas contractor, announced a five-part plan to increase business overseas in 1992. CNCCC will begin active exploration of markets in the Middle East, Southeast Asia, Africa, Latin America, and Eastern Europe, in addition to the Commonwealth of Independent States. The company will open offices in Western Europe, Southeast Asia, and the Middle East and expand existing offices in New York, Tokyo, Bangkok, Paris, Hong Kong, and Dacca, Bangladesh. New partners will be sought for joint ventures and the company will establish more subsidiaries at home. It also intends to establish closer cooperation with foreign trade companies in an effort to raise the export business to at least $100 million in 1995.

China Petrochemical International, a subsidiary of Sinopec known as Sinopec International, announced its immediate plans on Jan. 18. Feng Shikai, vice general manager of the firm, said his company has mapped out its market strategy for the next five years. Targets include importing technology and equipment to build a new ethylene plant (300,000 metric tons per year) at Maoming (Guandong). The company also will aid in transforming an ethylene plant at the Yanshan Petrochemical Corp. (another Sinopec subsidiary) from its present capacity of 300,000 metric tons per year to 450,000. This will be the largest ethylene plant in China. By the end of 1995, says Feng, Sinopec International will be involved in the construction of six new ethylene plants, three polyethylene plants, and three ammonia plants.

The key exports in Sinopec International's plans are minimally processed oil, petroleum coke, paraffin waxes, synthetic rubber, and synthetic resins. Deng Wenshen, deputy general manager of marketing research, says one of the biggest exports in the future is expected to be methyl *tert*-butyl ether (MTBE) for use as a gasoline additive. He projects that this year's market for MTBE in Japan will be 400,000 metric tons, and in the U.S. 2 million tons.

In looking at the development of China's chemical industry, it is apparent that most of it is based on the technology of 1960, with incremental improvements. Since 1983, with the onset of political and economic reforms, Sinopec has tried to bring the industry up to speed not only by enlarging capacity but also by acquiring state-of-the-art technology. On the day after Christmas, Sheng told a national conference of petrochemical managers that Sinopec had spent $750 million for imported technology and equipment in 1991. This, he said, represents the best investment that can be made over and above the maintenance of political stability inside China. □

## Sinopec produces bulk of China's petrochemicals

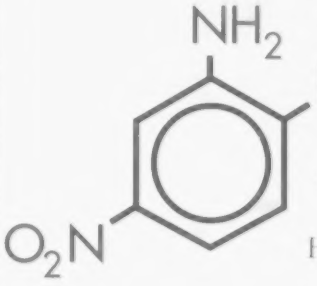
| Materials | Annual capacity (millions of metric tons) | % of China's total capacity |
|---|---|---|
| **Crude-oil refining** | 131 | 90.3% |
| **Total downstream petrochemicals** | 56.13 | 91.4 |
| **Ethylene** | 1.82 | 87.9 |
| **Downstream products** | | |
| Plastics | 1.96 | |
| Synthetic fiber monomers | 1.09 | |
| Synthetic fiber polymers | 0.52 | |
| Synthetic rubber | 0.25 | |
| Ammonia | 3.34 | |
| Urea | 5.26 | |
| Other organic feedstocks | 3.20 | |

Source: Sinopec


Hoechst offers out of R+D:

**2-Fluoro-5-nitroaniline**

now available in lab quantities in pilot plant quantities

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# First Set of 1992 PRF Grants Approved

At its December meeting the ACS Board of Directors approved 185 new or continuing ACS-PRF grants for fundamental research or scientific education, plus 31 supplements to existing grants for Summer Research Fellowships to benefit faculty from four-year colleges, and 58 undergraduate supplements to new AC and G grants to universities. These grants, committing $5,337,723 of the $14.7 million authorized for 1992, were recommended from the 617 proposals considered by the PRF Advisory Board in November of 1991.

The last meeting of the PRF Advisory Board to recommend 1992 grants is scheduled for May. Proposals for 1993 funding will be accepted at least through June for the November advisory board meeting. Information and application materials may be obtained from the Petroleum Research Fund, American Chemical Society, 1155—16th St., N.W., Washington, D.C. 20036, or by calling (202) 872-4481.

## ACS-PRF Grants for Fundamental Research in the Petroleum Field (Type AC)

**Jeanette Adams,** Emory U. Fragmentation Dynamics of Small Amide Radical Cations. $63,000

**Thomas A. Albright,** U of Houston. Reactions and Rearrangements in Organometallic and Solid-State Materials. $40,000

**John L. Anderson, Frederick Lanni,** Carnegie Mellon U. Diffusion, Flow, and Partitioning in Gels. $40,000

**Roger N. Anderson,** Columbia U. Sequence Stratigraphic Interpretation and Stratigraphic Modeling Study of Two Neogene Passive Margins. $40,000

**Rutherford Aris,** U of Minnesota. Reactions in Continuous Mixtures. $43,000

**Paul A. Baker,** Duke U. Burial Diagenesis of Dolomite—an Experimental and Field Study. $40,000

**Jay L. Banner,** U of Texas, Austin. Marine Burial Diagenesis of Carbonate Platforms and Secular Variations in Late-Devonian Seawater. $43,000

**Philip R. Brooks,** Rice U. How Does Molecular Orientation Affect Electron Transfer? $43,000

**David J. Burdige,** Old Dominion U. Coupled Nonlinear Models of Diagenetic Processes in Marine Sediments. $43,000

**Robert M. Bustin,** U of British Columbia. Direct Chemical Characterization of Kerogen Using Electron Microprobe and Micro-FTIR Techniques. $40,000

**Hugo S. Caram,** Lehigh U. A Random Walk Model for the Motion of Granular Solids. $40,000

**Bernard D. Coleman,** Rutgers U. Rheology of Cold Drawing of Polymeric Materials. $40,000

**Robert M. Corn,** U of Wisconsin, Madison. Second Harmonic Generation Studies of Molecular Orientation at the Interface of Two Immiscible Electrolyte Solutions. $39,995

**James A. Cowan,** Ohio State U. The Chemistry of Metal Cofactors in DNA-Processing Enzymes. $40,000

**Jeannie L. Darby,** U of California, Davis. Biodegradation of Hydrocarbon in Aquifers: Effects on Permeability and Relationship to Grain Size. $43,000

**E. James Davis,** U of Washington. The Spectroscopy of Hydrocarbon Microparticles. $40,000

**Joseph P. Dinnocenzo,** U of Rochester. Odd-Electron Substitution Reactions. $40,000

**Steven R. Emerson,** U of Washington. Early Diagenesis of Vanadium in Marine Sediments. $43,000

**Thomas P. Fehlner,** U of Notre Dame. Clusters as Substituents: a New Route to High-Nuclearity Clusters and Designed Materials. $43,000

**Udo Fehn,** U of Rochester. Systematics of $^{129}I$ in Marine Sediments. $40,500

**John P. Ferraris,** U of Texas, Dallas. Design and Synthesis of Low-Bandgap Polymers. $43,000

**Thomas C. Flood,** U of Southern California. General Acid/Base Catalysis of Reactions at Metal Centers. $40,000

**William C. Forsman,** U of Pennsylvania. Polymers at the Solid-Liquid Interface in Random Porous Media: Studies by Small-Angle Neutron Scattering. $40,000

**Eiichi Fukushima,** Lovelace Medical Foundation. Interphase Boundaries of Multiphase Flows in Porous Media: an NMR Imaging Study. $40,000

**Phillip H. Geil,** U of Illinois, Urbana-Champaign. Transitions in Polyhydroxybenzoic Acid—Mechanisms and "Liquid Crystal" Structures. $40,000

**John W. Geissman,** U of New Mexico. Paleomagnetic, Rock Magnetic, and Stable Isotope Investigation of Late Paleozoic Remagnetization of Precambrian Basement and Immediately Overlying Strata, Central and Southern Rocky Mountains. $43,000

**Peyman Givi,** State U of New York, Buffalo. Mixing and Reaction in Turbulent Flows. $43,000

**Alan S. Goldman,** Rutgers U. Alkane Carbonylation and Aldehyde Decarbonylation Catalyzed by Low-Valent Transition-Metal Complexes. $40,000

**Robert J. Gordon,** U of Illinois, Chicago. Dynamics of Oxygen Atoms on Multiple Potential Energy Surfaces. $40,000

**Harvey A. Gould,** Clark U. Computer Simulation Studies of the Structure and Dynamics of Model Atomic Glasses. $40,000

**Phillip L. Gould,** U of Connecticut. Experiments in Ultracold Collisions. $40,000

**Gordon W. Gribble,** Dartmouth C. Novel Syntheses of Highly Strained Organic Molecules. $40,000

**Gregory L. Griffin,** Louisiana State U. Aerosol Synthesis of Aluminum Nitride Preceramic Powders via Chemical Precursors. $40,000

**H. S. Gutowsky,** U of Illinois, Urbana-Champaign. High-Resolution Spectroscopy of Transient Species. $43,000

**William W. Hay,** U of Colorado. The Significance of Geology, Climate, and Local Relief on the Load of Rivers. $43,000

**Paul L. Heller,** U of Wyoming. The Stratigraphic Record of Alluvial Response to Base-Level Changes: Eocene Fan-Delta Sequences of Southeastern Ebro Basin, Spain. $43,000

**Teresa E. Jordan,** Cornell U. Seismic Stratigraphy of the Bermejo Foreland Basin, Argentina. $40,000

**Susan M. Kauzlarich,** U of California, Davis. Synthesis and Characterization of Novel Layered Compounds. $40,000

**William C. Kelly,** U of Michigan. Geologic and Thermochemical History of the White Pine District, Keweenaw Rift, Northern Michigan. $14,373

**Stephen E. Kesler,** U of Michigan. Cl/Br and $\delta^{18}O$-$\delta D$ Analyses of MVT-Forming Fluid Inclusion Brines, Southern and Central Appalachians. $40,000

**Douglas J. Klein, William A. Seitz,** Texas A&M U, Galveston. Comprehensive Generation and Partial Characterization of "Large" Elemental Carbon Cages. $40,000

**Joel Koplik,** City U of New York, City C. Hydrodynamic Dispersion in Flow in Porous Media. $40,000

**Sonja Krause,** Rensselaer Polytechnic Inst. Studies of Pore Structure in Polymeric Reverse Osmosis and Ultrafiltration Membranes Using SAXS, SANS, and Low-Angle Light Scattering. $40,000

**Stephen G. Kukolich,** U of Arizona. Microwave Measurements of Structures and Quadrupole Coupling for Transition-Metal Complexes. $40,000

**Mark Lautens,** U of Toronto. Ring-Opening Reactions of Oxabicyclic Compounds. $40,000

**Marsha I. Lester,** U of Pennsylvania. Determination of Realistic Intermolecular Potential Energy Surfaces for OH($X\ ^2\Pi$, $A\ ^2\Sigma^+$) + Ar. $40,000

**Dennis L. Lichtenberger,** U of Arizona. Electronic Structure and Bond Energy Trends in Metal-Carbon and Metal-Silicon Chemistry. $43,000

**Katja Lindenberg,** U of California, San Diego. Soliton Models of Proton/Energy Transport Mechanisms in Cyclodextrin. $40,000

**Kenneth B. Lipkowitz,** Indiana U-Purdue U, Indianapolis. Enantiodiscrimination on Chiral Polymers. $40,000

**Timothy P. Lodge,** U of Minnesota. Polymer Diffusion in Microstructured Media. $20,000

**Kyger C. Lohmann,** U of Michigan. Multitracer Analysis of Diagenetically Altered Corals in the Pleistocene Key Largo Limestone Implications for $^{230}Th$ Ages of Corals. $43,000

**Austin Long,** U of Arizona. Stable Chlorine Isotopes as Indicators of Source and/or Evolution of Basin Brine. $40,000

**William G. Madden,** Wayne State U. A Theoretical Framework for the Adsorption of Fluids into Disordered Media. $43,000

**Olivier R. Martin,** State U of New York, Binghamton. Stereoselective Synthesis of *C*-Glycosyl Compounds by way of Intramolecular Reactions of 2-Organosilyl Glycosides. $40,000

**Richard M. Martin,** U of California, Santa Barbara. Vibrational Enhancement of the Adsorption of Nitric Oxide and Formaldehyde on Metal and Semiconductor Surfaces. $40,000

**James M. Mayer,** U of Washington. Radical Reactions of Transition-Metal Oxo Complexes. $43,000

**Michael J. McKelvy, William S. Glaunsinger,** Arizona State U. Atomic-Level Imaging of Dynamic Staging Processes. $40,000

**Michael O. McWilliams,** Stanford U. Fission Track and $^{40}Ar/^{39}Ar$ Investigation of Metamorphism and Uplift in the Franciscan Subduction Complex, California. $40,000

**Josef Michl,** U of Colorado. A Molecular Carpet. $40,000

**Glenn L. Millhauser,** U of California, Santa Cruz. Development of Electron Overhauser Enhancement Spectroscopy (EOESY) as a New Technique for Revealing Peptide Geometry. $40,000

**Gautam Mitra,** U of Rochester. Growth History of a Fault Propagation Fold, Canyon Range, Utah. $40,000

**Almeria Natansohn,** Queen's U. Compatibilization of Polymer Blends by Charge-Transfer Interactions: an NMR Investigation. $40,000

**Keith A. Nelson,** Massachusetts Inst. of Technology. Picosecond-Microsecond Time-Resolved Spectroscopy of 1 MHz–100 GHz Coherent Acoustic Waves in Viscoelastic Fluids. $40,000

**Ronald E. Noftle,** Wake Forest U. Preparation, Polymerization, and Electrochemical Properties of Novel Thiophenes with Highly Electron-Withdrawing Groups in the 3-Position. $40,000

**H. Daniel Ou-Yang,** Lehigh U. Light-Scattering Studies of Polymer Adsorption on Colloidal Surfaces: Phase Transition and Kinetics. $43,000

**John Parnell,** Queen's U. Studies of Hydrocarbon Migration Using Bitumen-Mineral Relationship. $40,000

**Rinaldo Poli,** U of Maryland. The Energetic Effect of Unpaired Electrons in Organometallic Compounds. $43,000

**Raj Rajagopalan,** U of Houston. Interaction Forces in Dense Fluids and Colloidal Dispersions: the Inverse Problem. $43,000

**Andrzej Rajca,** Kansas State U. π-Conjugated Triplet Diradical Anions. $40,000

**Richard Robson,** U of Melbourne. New Infinite 2-D and 3-D Frameworks. $40,000

**Dean M. Roddick,** U of Wyoming. Heterolytic Activation of H–H and C–H Bonds. $43,000

**Juergen Schieber,** U of Texas, Arlington. Shale Microfabrics and Their Relationship to Mesofabrics and Sedimentary Environments: a Case Study of the Newland Formation, Montana. $35,000

**John M. Sharp Jr.,** U of Texas, Austin. Fluid and Heat Flow in Sedimentary Basins: Geologic and Hydrologic Constraints on a Thermal Anomaly in South Texas, Northern Gulf of Mexico Basin. $39,855

**Duncan F. Sibley,** Michigan State U. Dolomite Crystal Growth Rate. $43,000

**Scott McN. Sieburth,** State U of New York, Stony Brook. The Vinylsilane Diels–Alder Reaction. $43,000

**Peter E. Siska,** U of Pittsburgh. Energy Disposal and Dynamics in Penning Ionization Reactions. $40,000

**Gopalan Srinivasan,** Oakland U. Magnetic Ordering in Amorphous Transition-Metal Oxides. $40,000

**Eric M. Stuve,** U of Washington. Ex-situ Studies of the Electrochemical Double Layer. $40,000

**William C. Stwalley,** U of Iowa. Autoionization of Doubly Excited States of Alkali Metal Diatomics. $40,000

**Michael R. Topp,** U of Pennsylvania. Multiphoton Studies of Ionization in Molecular Clusters. $40,000

**Sukant K. Tripathy,** U of Massachusetts, Lowell. Novel Photocrosslinked Nonlinear Optical Polymers and Related Electrooptic Devices. $43,000

**Martin T. Vala Jr.,** U of Florida. Spectroscopic Studies of Aromatic Cations. $43,000

**Christopher Viney,** U of Washington. From Natural Silk Secretions to High-Performance Fibers. $50,000

**David H. Waldeck,** U of Pittsburgh. Experimental Studies of Encounter Pair Dynamics for a Model Bimolecular Reaction. $43,000

**Richard G. Weiss,** Georgetown U. Long-Range Photoinduced Electron-Transfer Processes Studied in Solid Phases of *n*-Alkanes. $40,000

**Emil H. White,** Johns Hopkins U. Trapping of Metastable Carbonium Ions To Yield Novel and Useful Products under Conditions of Kinetic Control. $43,000

**Gary A. Williams,** U of California, Los Angeles. Surface and Bulk Tortuosity of Porous Ceramics Near the Percolation Threshold. $43,000

**Andrew Wojcicki,** Ohio State U. Transition-Metal Oxo-Hydrido and Imido-Hydrido Complexes. Coupled Ligand Transfer Reactions to Unsaturated Substrates. $63,000

**L. Keith Woo,** Iowa State U. Coordination and Organometallic Chemistry of Metalloporphyrins. $40,000

## ACS-PRF Grants for Fundamental Research in the Petroleum Field (Type B)

**Brian J. Bozlee,** Whitman C. Surface-Enhanced Raman Spectroscopy of Metal Colloids. $20,000

**Michael P. Castellani,** Marshall U. Synthesis and Characterization of Pentaphenylcyclopentadienyl Stabilized Paramagnetic Transition-Metal Complexes. $20,000

**John D. Cooper,** California State U, Fullerton. Sheets or Shingles? A Case Study on the Origin of Laterally Extensive Sandstones of an Early Stage Continental Margin. $20,000

**Dru Germanoski,** Lafayette C. Reevaluation of Relationships between Bar-Forming Processes and Sedimentary Structures in Gravel-Bed Braided Rivers. $20,000

**Scott C. Hartsel,** U of Wisconsin, Eau Claire. Selectivity and Structure of Amphotericin B Channels. $20,000

**Bert E. Holmes,** Arkansas C. Kinetics and Dynamics of Unimolecular and Bimolecular Reactions of Halocarbons. $20,000

**Daniel M. Ketcha,** Wright State U. Synthesis of Natural Products Using *N*-Protected Pyrroles. $20,000

**Cheryl L. Klein,** Xavier U of Louisiana. High-Pressure X-Ray Diffraction Studies of Organic Molecules with Intermolecular Hydrogen Bonds. $20,000

**Kevin W. McLaughlin,** U of Southern Indiana. Molecular Structure Distributions for Polymers Synthesized with Heterogeneous Ziegler–Natta Catalysts. $20,000

**Roger S. Rowlett,** Colgate U. Structure and Catalytic Mechanism of Plant Carbonic Anhydrase. $20,000

**Charles D. Schaeffer Jr.,** Elizabethtown C. Dimethylphosphaneborane Chemistry. $20,000

**Lawrence C. Thomas,** Seattle U. Quantitative Dual-Isotope Comparisons of Reaction Product Abundances by GC-MS. $20,000

**Larry C. Thompson,** U of Minnesota, Duluth. Possible Geometric Isomerism in Adducts of the Rare Earth β-Diketonates. $20,000

**Hal Van Ryswyk,** Harvey Mudd C. Electrochemical Studies of Ion Penetration through Self-Assembling Monolayers. $20,000

**Stephen R. Wassall,** Indiana U-Purdue U, Indianapolis. Deuterium Nuclear Magnetic Resonance Studies of Positional Isomers of an Unsaturated Phospholipid Bilayer. $20,000

## ACS-PRF Grants for Fundamental Research in the Petroleum Field (Type G)

**Leslie H. Allen,** U of Illinois, Urbana-Champaign. Growth and Characterization of Si, SiGe, and Carbon Crystals by Low-Temperature Selective Area Solid-Phase Epitaxy Using Metal Eutectics. $18,000

**Rafael Alvarez-Gonzalez,** Texas C of Osteopathic Medicine. Chemical and Kinetic Mechanisms of Enzyme-Catalyzed Polymerization Reactions. $21,000

**Gray E. Bebout,** Lehigh U. Application of Nitrogen Isotopes to Studies of Crustal Volatile Production and Transport. $21,000

**David B. Berkowitz,** U of Nebraska, Lincoln. Synthesis and Evaluation of a Class of Mechanism-Based Inhibitors for Phosphoryl Transfer Enzymes. $21,000

**Craig R. Bina,** Northwestern U. Thermodynamic Constraints upon Lithospheric Structure, Composition, and Mineralogy. $18,000

**D. Scott Bohle,** U of Wyoming. Lower Phosphorus Sulfides and Oxides as Reactive Intermediates. $21,000

**Mary K. Boyd,** Loyola U of Chicago. Photochemistry of 9-Xanthylium Ions. $21,000

**Lee Brammer,** U of Missouri, St. Louis. High-Resolution Diffraction Studies of Transition-Metal-Hydrogen Interactions. $21,000

**Rebecca Braslau,** U of California, Santa Cruz. Enantioselective Hydrogen Abstraction by Prochiral Radicals. $21,000

**Kevin L. Bray,** U of Wisconsin, Madison. Effect of Pressure on Optical Properties of Paramagnetic Ion Laser Materials. $18,000

**Wesley R. Burghardt,** Northwestern U. Polymer Crystallization in Immiscible Solutions and Blends. $21,000

**James W. Canary,** New York U. $C_3$-Symmetric Organometallic Receptors. $18,000

**H. Keith Chenault,** U of Delaware. Enzyme-Catalyzed Glycosylations Using Glycals and Glycosyl Phosphates as Glycosyl Donors. $21,000

**Jerzy Cioslowski,** Florida State U. Rigorous Interpretation of Electronic Wavefunctions: Electronic Structures of Boron Hydrides and Other Electron-Deficient Molecules. $18,000

**David M. Collard,** Georgia Inst. of Technology. Control of Conducting Polymer Morphology by Self-Assembly of Electroactive Monomers. $21,000

**Dale G. Drueckhammer,** Stanford U. Enzymatic Synthesis of Coenzyme A Analogs. $18,000

**Menachem Elimelech,** U of California, Los Angeles. Coupling between Hydrodynamics and Colloidal Interactions in Particle Deposition in Porous Media. $18,000

**Randy S. Fishman,** North Dakota State U. Void Formation in Organic Coatings. $21,000

**Lorraine F. Francis,** U of Minnesota. Structural Evolution of Porous Titania Coatings. $21,000

**Vasilios Galiatsatos,** U of Akron. Fundamental Optical Studies of Polymer Networks. $21,000

**Robert T. Hembre,** U of Nebraska, Lincoln. Four-Electron Redox-Coupled Reductive Elimination in Oxo-Metal Clusters. $18,000

**David J. Jebaratnam,** Northeastern U. A Novel Strategy for Receptor Design and Synthesis. $18,000

**John F. Kauffman,** U of Missouri, Columbia. Picosecond Time-Resolved Laser Studies of Solvation and Reactivity in Supercritical Fluids. $21,000

**Chaitan Khosla,** Stanford U. Understanding Structure-Function Relationships in Polyketide Syntheses. $21,000

**C. Vijaya Kumar,** U of Connecticut. Probing Hydrophobic Binding Sites in the Grooves of the DNA Double Helix. $18,000

**Donald P. Land,** U of California, Davis. Time-Dependent Analysis of Surface Molecular Composition. $18,000

**Sara Majetich,** Carnegie Mellon U. Measurement of Size-Dependent Cadmium Sulfide Microcrystallite Properties. $18,000

**Nancy Makri,** U of Illinois, Urbana-Champaign. Quantum Mechanical Approach to Molecule-Surface Reaction Dynamics. $18,000

**Peter S. Mozley,** New Mexico Inst. of Mining and Technology. Diagenesis of the Ivishak Formation, North Slope, Alaska: a Petrographic and Geochemical Study. $21,000

**Margaret M. Murnane,** Washington State U. Picosecond X-Ray Molecular Dynamics. $18,000

**Steven P. Nolan,** U of New Orleans. Thermochemistry of Olefin Iron Carbonyl Complexes: Thermochemistry Related to Olefin Catalysis. $21,000

**James S. Nowick,** U of California, Irvine. Template Catalysis of the Diels-Alder Reaction. $21,000

**Francisca E. Oboh,** U of Missouri, Rolla. Palynostratigraphy and Climatic History of the Lower Oligocene in the Eastern Gulf Coast. $21,000

**Raymond A. Pearson,** Lehigh U. Determining the Minimum Particle Size for Rubber-Toughened Epoxies. $18,000

**Piotr Piotrowiak,** U of New Orleans. Intramolecular Excitation Transfer Bands. $21,000

**John A. Pojman,** U of Southern Mississippi. Traveling Fronts of Addition Polymerizations. $21,000

**Richard T. Scalettar,** U of California, Davis. Quantum Simulations of Bose Systems: Applications to Superconductor-Insulator Phase Transitions. $18,000

**Jurgen Schnitker,** U of Michigan. Dynamical Simulation of Liquids with Semiempirical Electronic Structure Techniques. $18,000

**Pamela J. Shapiro,** U of Idaho. Investigation of the Synthesis and Reactivity of Bent Chromocene Complexes Having Linked Cyclopentadienyl Ligands. $21,000

**Andrew K. Shiemke,** West Virginia U School of Medicine. Biological Methane Oxidation: Spectroscopic Characterization of Methane Monooxygenase. $18,000

**Seung K. Shin,** U of California, Santa Barbara. FT-ICR Studies of Organometallic Reaction Mechanisms. $18,000

**Bradley D. Smith,** U of Notre Dame. The Synthesis and Study of Photoresponsive Receptors and Catalysts. $21,000

**Thomas C. Squier,** U of Kansas. Relationships between Acyl Chain Structure and Bilayer Stability. $21,000

**Keith J. Stine,** U of Missouri, St. Louis. Studies of Phase Behavior and Domain Structures in Langmuir Monolayers. $18,000

**Paul J. Strykowski,** U of Minnesota. The Effect of Counterflow on the Stability and Mixing of Variable Density Jets. $18,000

**Gary A. Sulikowski,** Texas A&M U. Development of Copper-Catalyzed Asymmetric Photochemical Processes. $21,000

**Claire Welty,** Drexel U. Stochastic Analysis of Dispersive Transport of Variable Density and Viscosity Fluids in Porous Media: Extension to the Anisotropic Case. $18,000

**Vicki H. Wysocki,** Virginia Commonwealth U. Structure and Reactivity of Novel Distonic Radical Cations and Anions. $21,000

**Luping Yu,** U of Chicago. New Polymeric Materials for Nonlinear Optics. $18,000

**Chong Zheng,** Northern Illinois U. Studies of Thermodynamic Properties of Solid-State Materials. $21,000

**Samuel A. Abrash,** U of Richmond. Wavelength Dependence and Polarization Studies of Hydrogen-Bonded Complexes in Inert Gas Matrices. $18,000

**Christopher R. Arumainayagam,** Wellesley C. Studies of Collision-Induced Surface Chemistry. $18,000

**A. M. R. P. Bopegedera,** Evergreen State C. Infrared Spectroscopy of Metal Monohydrides, Monodeuterides, and Monohalides. $18,000

**Ronald G. Brisbois,** Davidson C. Application of Aromatic Annulation Strategies to the Synthesis of [m.n]orthoparacyclophanes. $18,000

**Laura F. Cooley,** Rhode Island C. Excited-State Equilibrium Constants and Proton Transfer Rates in a Series of Ruthenium Complexes. $18,000

**Ronald J. Duchovic,** Indiana U-Purdue U, Fort Wayne. Bimolecular Kinetics and Reaction Dynamics. $18,000

**Mark A. Evans,** Georgia Southern U. The Migration of Fluids along Regional Decollements in a Foreland Fold-and-Thrust Belt. $18,000

**Douglas H. Green,** Ohio U. Compressional and Shear Wave Attenuation Mechanisms in Fluid-Saturated Silicic Clastics at Elevated Pressures. $18,000

**Arthur S. Hewitt,** California State U, Fullerton. Mechanistic and Kinetic Study of the OH + Toluene Reaction Using Laser Ionization Methods. $18,000

**Helen O. Leung,** Williams C. Pulsed Molecular-Beam Fourier-Transform Microwave Spectroscopic Study of Weakly Bound Complexes of Unsaturated Molecules. $18,000

**Jennifer L. Muzyka,** Roanoke C. Temperature Effects on Semiconductor Photocatalyzed Reactions. $18,000

**Cynthia S. St. Clair,** Cornell C. Metal Substitution Studies of the Blue Copper Protein Rusticyanin. $18,000

## ACS-PRF Grants for Fundamental Research in the Petroleum Field (Type SE)

**Udo H. Brinker,** on behalf of SUNY, Binghamton, and the 24th Reactions Mechanisms Conference Committee. Reactions Mechanisms, 24th Reaction Mechanisms Conference, Orono, Me., June 1992. $2000

**Malcolm H. Chisholm, Cynthia M. Friend,** on behalf of the ACS Division of Inorganic Chemistry. The Related Chemistries of Clusters, Surfaces, and Solids, ACS national meeting, Washington, D.C., fall 1992. $2000

**Richard M. Crooks,** on behalf of the ACS Division of Colloid & Surface Chemistry. Photochemical and Electrochemical Surface Science, ACS national meeting, Washington, D.C., fall 1992. $2000

**Anthony W. Czarnik,** on behalf of the ACS Division of Organic Chemistry. Fluorescent Chemosensors of Molecular Recognition, ACS national meeting, Washington, D.C., fall 1992. $2000

**Franklin A. Davis,** on behalf of the ACS Division of Organic Chemistry. Recent Advances in Carbanion Chemistry, ACS national meeting, Washington, D.C., fall 1992. $1000

**Kenneth A. Dawson,** on behalf of the ACS Division of Physical Chemistry. Complex Interfaces, ACS national meeting, San Francisco, spring 1992. $2000

**Paul L. Dubin,** on behalf of the ACS Division of Colloid & Surface Chemistry. Colloid-Polymer Interactions, ACS national meeting, San Francisco, spring 1992. $2000

**Alan D. English,** on behalf of the ACS Divison of Polymer Chemistry. Molecular Dynamics, ACS national meeting, San Francisco, spring 1992. $2000

**K. H. Gardner,** on behalf of the ACS Division of Polymer Chemistry Inc. X-Ray and Electron Diffraction from Polymers, ACS national meeting, San Francisco, spring 1992. $2000

**Robert H. Grubbs,** on behalf of the ACS Division of Inorganic Chemistry. Organometallic Reagents and Catalysts, ACS national meeting, San Francisco, spring 1992. $2000

**George R. Helz,** on behalf of the ACS Division of Geochemistry. Environmental Aspects of Aquatic and Surface Photochemistry, ACS national meeting, San Francisco, spring 1992. $2000

**Richard F. Jordan,** on behalf of the ACS Division of Inorganic Chemistry. Chemistry of Electrophilic Metal Complexes, ACS national meeting, Washington, D.C., fall 1992. $2000

**Kopin Liu,** on behalf of the ACS Division of Physical Chemistry. State-to-State Dynamics on Multiple Potential Energy Surfaces, ACS national meeting, San Francisco, spring 1992. $2000

**Donald W. Murphy,** on behalf of the ACS Division of Inorganic Chemistry. Magnetic and Electron Properties of Metal Oxides, ACS national meeting, San Francisco, spring 1992. $2000

**Paul S. Russo, W. Wade Adams,** on behalf of the ACS Division of Polymer Chemistry Inc. Macromolecules and the New Microscopy, ACS national meeting, San Francisco, spring 1992. $2000

**Martin D. Saltzman,** on behalf of the ACS Division of the History of Chemistry. C. K. Ingold: Master and Mandarin of Physical Organic Chemistry, ACS national meeting, Chicago, fall 1993. $1000

**Bruce A. Scott,** on behalf of the ACS Division of Inorganic Chemistry. Recent Advances in Solid-State Chemistry, ACS national meeting, Washington, D.C., fall 1992. $2000

**Doros N. Theodorou,** on behalf of the ACS Division of Polymer Chemistry. Modeling and Computer Simulation of Polymers, ACS national meeting, San Francisco, spring 1992. $2000

**Albert F. Wagner, David M. Golden,** on behalf of the ACS Division of Physical Chemistry. Physical Chemistry in Atmospheric Science and Combustion: Kinetics of Radical-Radical Reactions, ACS national meeting, San Francisco, spring 1992. $2000

## ACS-PRF Summer Research Supplements to Type AC Grants

**Laurie J. Butler,** U of Chicago. Molecular Dissociation Dynamics through Conical Intersections Studied via Polarized Emission Spectroscopy. $5000

**Donald C. Dittmer,** Syracuse U. Elemental Tellurium in the Synthesis of Optically Active Compounds. $5000

**Harry C. Dorn,** Virginia Polytechnic Inst. and State U. Dynamic Nuclear Polarization—a New Approach for Chiral Recognition. $5000

**Azriel Z. Genack, Narciso Garcia,** City U of New York, Queens C. Wave Propagation and Localization in Random Structures. $5000

**Lionel Goodman,** Rutgers U. Two-Photon Rydberg Transition Jet Spectroscopy Involving Torsional Modes. $5000

**Daniel C. Hong,** Lehigh U. Viscous Fingering and Pattern Formation. $5000

**Louis L. Jacobs,** Southern Methodist U. Biostratigraphy of Lower Cretaceous Terrestrial Deposits, Texas. $5000

**Carey K. Johnson,** U of Kansas. Spectroscopic Hole-Burning Studies of Bacteriorhodopsin and Rhodopsin. $5000

**Mercouri G. Kanatzidis,** Michigan State U. Soluble Polychalcogenide Chemistry of Late-Transition and Main-Group Metals. $5000

**Joseph W. Lauher, Frank W. Fowler,** State U of New York, Stony Brook. An Approach to the Design of Molecular Solids. $5000

**Frederick D. Lewis,** Northwestern U. Applications of Intra- and Intermolecular Hydrogen Bonding in Organic Photochemistry. $5000

**Joseph S. Merola,** Virginia Polytechnic Inst. and State U. Iridium Alkyne Chemistry: an Unusual Pathway to Novel Alkyne Polymers and Oligomers. $5000

**Janet R. Morrow,** State U of New York, Buffalo. Metal-Catalyzed Substitution at Phosphorus(V): RNA Cleavage. $5000

**Jonathan C. Sokolov, Miriam H. Rafailovich,** City U of New York, Queens C. The Form of the Concentration Profile at the Surface and Interface of Polymer Blends. $5000

**Douglas W. Stephan,** U of Windsor. Early Metal Dithiolate Complexes: Macrocyclic Metalloligands. $5000

**John L. Stickney,** U of Georgia. Electrochemical Atomic Layer Epitaxy. $5000

**Wiley J. Youngs,** U of Akron. Transition-Metal Complexes of Helical Substituted Fulvalenes. $5000

**Matthew B. Zimmt,** Brown U. Picosecond Optically Detected Calorimetry: Dynamics and Energetics of Ultrafast Reactions in Solution. $5000

## ACS-PRF Summer Research Supplements to Type B Grants

**Eric J. Cotts,** State U of New York Binghamton. Calorimetric Investigation of the Properties of Solids. $5000

**Gregory J. Grant,** U of Tennessee, Chattanooga. Transition-Metal Complexes of Crown Thioether Ligands. $5000

**James H. Meyers,** Winona State U. Influence of Basement Structure upon Differential Subsidence and Uplift in the Early Rocky Mountain Foreland Basin: the Ellis Group of Western Montana. $5000

**Rabindra N. Roy,** Drury C. Thermodynamic Study of Electrolyte Mixtures. $5000

**Jill S. Schneiderman,** Pomona C. Metamorphic and Tectonic Histories of Suspect Terranes, San Gabriel Mountains, California. $5000

**Bruce N. Storhoff,** Ball State U. The Synthesis and Study of Functionalized Crown Ether and Crown Thia Ether Molecules. $5000

## ACS-PRF Summer Research Supplements to Type G Grants

**Jeffrey R. Appling,** U of Kentucky. Photofragment Alignment in Molecular Photodissociation. $5000

**Bruce E. Bowler,** U of Denver, Colorado Seminary. The Role of Hydrogen Bonds in Mediating Electron Transfer. $5000

**Randolph S. Duran,** U of Florida. Monolayers and Multilayers of Side-Chain Liquid Crystalline Polymers. $5000

**W. Dean Harman,** U of Virginia. Activation of Arenes by their Dihapto-Coordination. $5000

**Jon R. Kirchhoff,** U of Toledo. Synthesis and Characterization of Rhenium(I) Photocatalysts. $5000

**Mark S. Meier,** U of Kentucky. Chemical Effects of the Peptide Helix Macrodipole Moment. $5000

**Xiangdong Zhu,** U of California, Davis. An Experimental Study of Quantum Tunneling Diffusion on Surfaces: Hydrogen and Deuterium on Metals. $5000 □